

## DEVICE FOR LIMITING MOVEMENT OF A BODY IN RELATION TO ANOTHER

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### FIELD OF THE INVENTION

The present invention relates generally to movement mechanisms and more particularly to devices for limiting the movement of a body in relation to another.

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### BACKGROUND OF THE INVENTION

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In some applications, it is often desirable to provide a user access to the contents of a container such as a drawer but, for safety and other reasons, not permit him to completely remove the container from its assigned slot without releasing an interlock. One example of many such applications occurs in magnetic tape libraries. Tape libraries are used in computer systems as a convenient means of storage and retrieval of large amounts of data. The data is stored on magnetic tape with each tape mounted in a holder. The combined tape and holder are referred to as a tape cartridge. The tape cartridges are loaded onto trays within the tape library for storage and subsequent selection. When data from a particular tape is required, the tray on which its cartridge is stored is moved by a magnetic tape autochanger, which is a component of the tape library, to the vicinity of a magnetic tape reader. The tape cartridge is removed from its tray and positioned in the tape reader where its data is then read by the tape reader.

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In such systems, it is typically necessary to provide the user access to the tape cartridges for cartridge loading and unloading. As an example, individual cartridges or groups of cartridges may need to be removed from the autochanger as they wear-out or, for data safety, stored off-site.

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In typical systems, when a user desires to add or remove a particular cartridge he does so by first requesting it via either the front panel of the autochanger or the host

computer. The autochanger then moves the tray on which the selected cartridge resides to a special drawer, typically referred to as a mailbox, that the autochanger uses for such access. The system then actuates a solenoid so that the drawer can be partially opened thereby providing access to the cartridge.

5 An interlock is provided to inhibit complete removal of the drawer. For complete removal of the drawer, the interlock is first released. In typical autochangers this interlock comprises an expensive panel and/or computer-actuated solenoid.

## 10 SUMMARY OF THE INVENTION

In one embodiment, a device for limiting the movement of a first body in relation to a second body is disclosed which includes a bendable piece of material, wherein the piece includes a first section and a second section contiguous to the first section, wherein  
15 the second section forms a first angle with respect to the first section, wherein the first angle is measured in a counter-clockwise direction from the first section, wherein the first angle is at least zero degrees and is less than 135 degrees when the piece is un-deflected, and wherein at least a portion of the first section is attachable to the second body.

## 20 BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings provide visual representations which will be used to more fully describe the invention and can be used by those skilled in the art to better  
25 understand it and its inherent advantages. In these drawings, like reference numerals identify corresponding elements and:

Figure 1A is a drawing of a device for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

30 Figure 1B is a drawing of the device of figure 1A located in a first position for

limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 1C is another drawing of the device of figure 1A located in a second position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 1D is a drawing of another embodiment of the device of figure 1A for limiting the movement of one body in relation to another with minimum value of first angle consistent with the teachings of the invention.

Figure 2A is a drawing of another embodiment of the device for limiting the movement of one body in relation to another consistent with the teachings of the invention.

Figure 2B is a drawing of the device of figure 2A located in the first position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 2C is another drawing of the device of figure 2A located in the second position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 2D is a drawing of <sup>another</sup> ~~another~~ embodiment of the device of figure 2A for limiting the movement of one body in relation to another with minimum value of first angle consistent with the teachings of the invention.

Figure 3A is a drawing of a further embodiment of the device for limiting the movement of one body in relation to another consistent with the teachings of the invention.

Figure 3B is a drawing of the device of figure 3A located in the first position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 3C is another drawing of the device of figure 3A located in the second position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 4A is drawing of still another embodiment of the device for limiting the

movement of one body in relation to another consistent with the teachings of the invention.

Figure 4B is a drawing of the device of figure 4A located in the first position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 4C is another drawing of the device of figure 4A located in the second position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 5 is a drawing of an example application of an embodiment of the device for limiting the movement of one body in relation to another consistent with the teachings of the invention.

Figure 6 is another drawing of the example application of figure 5 of the device for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in the drawings for purposes of illustration, the present patent document relates to a novel device for limiting the movement of one body in relation to another. In particular, a device is described which acts as an inexpensive interlock to limit movement of a body in relation to another. Such a device will be discussed in connection with its use in a tape library autochanger to inhibit complete removal of a drawer containing magnetic tape cartridges. For complete removal of the drawer, the interlock is easily released. Previous devices used as interlocks in such applications have relied upon expensive panel and/or computer actuated solenoids. The present patent document discloses a simpler, less expensive device. While the example shown is described in connection with a magnetic tape autochanger, the invention is not so limited.

In the following detailed description and in the several figures of the drawings, like elements are identified with like reference numerals.

Figure 1A is a drawing of a device **100** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In a first representative embodiment as shown in figure 1A, the device **100**, also referred to herein as lock spring **100** and as interlock **100**,  
5 comprises a piece **102** of material which could be fabricated as a wire **102**, a sheet stainless spring steel **102**, a band **102**, a molded part **102**, or the like. The piece **102** comprises first and second sections **105,110**. A distal portion of the first section **105** is referred to as a portion **145** in subsequent discussion.

In the un-deflected condition of figure 1A, a first angle **125** is formed between  
10 first and second sections **105,110** with vertex at first vertex **V1**. The first angle **125** is measured in a counter-clockwise direction from the first section **105**.

Figure 1B is a drawing of the device **100** of figure 1A located in a first position **215** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In the  
15 representative embodiment of figure 1B, the lock spring **100** shown is that of the first representative embodiment of figure 1A and is attached to a second body **210** at portion **145**. A first body **205** comprising a stop **212** is prevented from motion in a preselected direction **225** past the lock spring **100** by the impact of stop **212** against the second section **110**. In a typical application, the first body **205** is constrained to movement along  
20 an axis parallel to that of the preselected direction **225** by tracks attached to the second body **210**. With the lock spring **100** in the first position **215** as shown in figure 1B, the first body **205** is free to move in the direction opposite to the preselected direction **225** until restricted by other components of the second body **210** not shown in the figures. Also shown in figure 1B is a tool **230**, which could be, for example, a screwdriver **230**.

25 Figure 1C is another drawing of the device **100** of figure 1A located in a second position **220** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In figure 1C, the lock spring **100** has been moved to the second position **220** by a force applied by the tool **230** to the second section **110**. In the second position **220**, the second  
30 section **110** has been depressed far enough that it no longer impedes the movement of the

first body **205** past the second body **210**. The force required to move the lock spring **100** from the first position **215** to the second position **220** is preferably of a magnitude easily applied by hand and is, in some embodiments, less than one pound.

Practical minimum and maximum values for the first angle **125** are  
5 implementation-dependent. In general, however, characteristics of importance in the implementation are (1) for the lock spring **100** to impede, if not completely stop, motion of the first body **205** in the preselected direction **225** by impacting the stop **212**, (2) for the tool **230** to be capable of accessing the second section **110** in order to deflect it from the first position **215** to the second position **220** when removing the first body **205** from  
10 its position relative to the second body **210**, and (3) for the first body **205** to be able to move relatively freely in the opposite direction to that of the preselected direction **225** when replacing the first body **205** in position relative to the second body **210**. The specific materials chosen for the stop **212** and for the lock spring **100**, as well as the geometry chosen for the stop **212** will have a significant impact on the success in  
15 attaining the above important characteristics. A practical range for the first angle **125** is at least zero degrees and less than 135 degrees with typical, preferred value being 45 degrees.

Figure 1D is a drawing of another embodiment of the device **100** of figure 1A for limiting the movement of one body in relation to another with minimum value of first  
20 angle **125** consistent with the teachings of the invention. In figure 1D, the first angle **125** is equal to zero degrees.

Figure 2A is a drawing of another embodiment of the device **100** for limiting the movement of one body in relation to another consistent with the teachings of the invention. In a second representative embodiment as shown in figure 2A, the device **100**,  
25 also referred to herein as lock spring **100** and as interlock **100**, comprises a piece **102** of material which could be fabricated as a wire **102**, sheet stainless spring steel **102**, a band **102**, a molded part **102**, or the like. The piece **102** comprises first and second sections **105, 110** and in addition a third section **115**. A distal portion of the first section **105** is referred to as the portion **145** in subsequent discussion.

30 In the un-deflected position of figure 2A, the first angle **125** is formed between

first and second sections 105,110 with vertex at first vertex V1. The first angle 125 is measured in a counter-clockwise direction from the first section 105. Also, in the undeflected position of figure 2A, a second angle 130 is formed between parallel translation of the first section 105 and the third section 115 with vertex at second vertex V2. The  
5 second angle 130 is measured in a counter-clockwise direction from the parallel translation of the first section 105.

Figure 2B is a drawing of the device 100 of figure 2A located in the first position 215 for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In the  
10 representative embodiment of figure 2B, the lock spring 100 shown is that of the second representative embodiment of figure 2A and is attached to the second body 210 at portion 145. The first body 205 comprising the stop 212 is prevented from motion in the preselected direction 225 past the lock spring 100 by the impact of stop 212 against the second section 110. In a typical application, the first body 205 is constrained to  
15 movement along an axis parallel to that of the preselected direction 225 by tracks attached to the second body 210. With the lock spring 100 in the first position 215 as shown in figure 2B, the first body 205 is free to move in the direction opposite to the preselected direction 225 until restricted by other components of the second body 210 not shown in the figures. Also shown in figure 2B is the tool 230, which could be, for  
20 example, the screwdriver 230.

Figure 2C is another drawing of the device 100 of figure 2A located in the second position 220 for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In figure 2C, the lock spring 100 has been moved to the second position 220 by force  
25 applied by the tool 230 to the third section 115. In the second position 220, the second section 110 has been depressed far enough that it no longer impedes the movement of the first body 205 past the second body 210. For the second representative embodiment shown in figure 2A, the force used to move the lock spring 100 to the second position 220 is applied to the third section 115 or to the intersection of the second and third  
30 sections 110,115.

Again practical minimum and maximum values for the first angle 125 are implementation dependent, as discussed in connection with the embodiments of figures 1A-1D. A practical range for the first angle 125 is at least zero degrees and less than 135 degrees with typical, preferred value being 90 degrees. A practical range for the second  
5 angle 130 is greater than or equal to 180 degrees and less than 270 degrees with typical, preferred value being 225 degrees.

Figure 2D is a drawing of another embodiment of the device 100 of figure 2A for limiting the movement of one body in relation to another with minimum value of first angle 125 consistent with the teachings of the invention. In figure 2D, the first angle 125  
10 is equal to zero degrees and the second angle 130 is 180 degrees.

Figure 3A is a drawing of a further embodiment of the device 100 for limiting the movement of one body in relation to another consistent with the teachings of the invention. In a third representative embodiment as shown in figure 3A, the device 100, also referred to herein as lock spring 100 and as interlock 100, comprises the piece 102  
15 of material which again could be fabricated as a wire 102, sheet stainless spring steel 102, a band 102, a molded part 102, or the like. The piece 102 again comprises the first, second, and third sections 105, 110, 115 and in addition a fourth section 120. A distal portion of the first section 105 is referred to as the portion 145 in subsequent discussion.

In the un-deflected position of figure 3A, the first angle 125 is formed between  
20 first and second sections 105, 110 with vertex at first vertex V1. The first angle 125 measured in a counter-clockwise direction from the first section 105. Also, in the un-deflected position of figure 3A, the second angle 130 is formed between parallel translation of the first section 105 and the third section 115 with vertex at second vertex V2. The second angle 130 measured in a counter-clockwise direction from the parallel  
25 translation of the first section 105. In addition, a third angle 135 is formed between parallel translation of the first section 105 and the fourth section 120 with vertex at third vertex V3. The third angle 135 is measured in a counter-clockwise direction from the parallel translation of the first section 105 at third vertex V3.

Figure 3B is a drawing of the device 100 of figure 3A located in the first position  
30 215 for limiting the movement of one body in relation to another as described in various



representative embodiments consistent with the teachings of the invention. In the representative embodiment of figure 3B, the lock spring 100 shown is that of the third representative embodiment of figure 3A and is attached to the second body 210 at portion 145. The first body 205 comprising the stop 212 is prevented from motion in the  
5 preselected direction 225 past the lock spring 100 by the impact of stop 212 against the second section 110. In a typical application, the first body 205 is constrained to movement along the axis parallel to that of the preselected direction 225 by tracks attached to the second body 210. With the lock spring 100 in the first position 215 as shown in figure 3B, the first body 205 is free to move in the direction opposite to the  
10 preselected direction 225 until restricted by other components of the second body 210 not shown in the figures. Also shown in figure 3B is the tool 230, which could be, for example, screwdriver 230.

Figure 3C is another drawing of the device 100 of figure 3A located in the second position 220 for limiting the movement of one body in relation to another as described  
15 in various representative embodiments consistent with the teachings of the invention. In figure 3C, the lock spring 100 has been moved to the second position 220 by the force applied by the tool 230 to the fourth section 120. In the second position 220, the second section 110 has been depressed far enough that it no longer impedes the movement of the first body 205 past the second body 210. For the third representative embodiment shown  
20 in figure 3A, the force used to move the lock spring 100 to the second position 220 is preferably applied to the fourth section 120.

Practical minimum and maximum values for first, second, and third angles 125,130,135 are implementation dependent. In general, however, characteristics of importance in the implementation are (1) for the lock spring 100 to impede, if not  
25 completely stop, motion of the first body 205 in the preselected direction 225 by impacting the stop 212, (2) for the tool 230 to be capable of accessing the fourth section 120 in order to deflect it from the first position 215 to the second position 220 when removing the first body 205 from its position relative to the second body 210, and (3) for the first body 205 to be able to move relatively freely in the opposite direction to that of  
30 the preselected direction 225 when replacing the first body 205 in position relative to the

second body 210. The specific materials chosen for the stop 212 and for the lock spring 100, as well as the geometry chosen for the stop 212 will have a significant impact on the success in attaining the above important characteristics. In this embodiment, a practical range for the first angle 125 is at least zero degrees and less than 135 degrees with typical, preferred value being 90 degrees. A practical range for the second angle 130 is greater than or equal to 180 degrees and less than 270 degrees with typical, preferred value being 225 degrees. In addition, a practical range for the third angle 135 is greater than or equal to 135 degrees and less than 225 degrees with typical, preferred value being 180 degrees.

Figure 4A is drawing of still another embodiment of the device 100 for limiting the movement of one body in relation to another consistent with the teachings of the invention. In a fourth representative embodiment as shown in figure 4A, the device 100, also referred to herein as lock spring 100 and as interlock 100, comprises a base 150 which could be fabricated as a wire 102, sheet stainless spring steel 102, a band 102, a molded part 102, or the like. The base 150 comprises a first and second segments 160, 165 and has a protrusion 155 attached to it. The protrusion 155 could be formed by any of various means including, but not limited to, the forming of a kink on the base 150 wherein the base is a wire. The protrusion 155 could also be extruded from the base 150 wherein the base is a strip of material. A distal portion of the first segment 160 will be referred to as an area 170 in subsequent discussion.

Figure 4B is a drawing of the device 100 of figure 4A located in the first position 215 for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In the representative embodiment of figure 4B, the lock spring 100 shown is that of the fourth representative embodiment of figure 4A and is attached to the second body 210 at area 170. The first body 205 comprising the stop 212 is prevented from motion in the preselected direction 225 past the lock spring 100 by the impact of stop 212 against the protrusion 155. In a typical application, the first body 205 is constrained to movement along an axis parallel to that of the preselected direction 225 by tracks attached to the second body 210. With the lock spring 100 in the first position 215 as shown in figure

4B, the first body **205** is free to move in the direction opposite to the preselected direction **225** until restricted by other components of the second body **210** not shown in the figures. A knowledge of these components is not necessary for an understanding of the invention. Also shown in figure 4B is the tool **230**, which could be for example screwdriver **230**.

5        Figure 4C is another drawing of the device **100** of figure 4A located in the second position **220** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In figure 4C, the lock spring **100** has been moved to the second position **220** by force applied by the tool **230** to the second segment **165**. In the second position **220**, the  
10       protrusion **155** has been depressed far enough that it no longer impedes the movement of the first body **205** past the second body **210**.

      Figure 5 is a drawing of an example application of an embodiment of the device **100** for limiting the movement of one body in relation to another consistent with the teachings of the invention. Figure 5 shows the first body **205** which in this examples is  
15       the drawer **205** of an autochanger of a magnetic tape library used for data storage in computer systems. The drawer **205** contains a magazine tray **505** on which are loaded two tape magazines **510** each of which hold five tape cartridges **515** in this example. When the user desires to open the drawer **205**, he does so by first requesting it via either the front panel of the autochanger or via the host computer. His request may include the  
20       movement of a specific tape cartridge **515** with associated magazine tray **505** to the drawer **205**. The system then actuates a solenoid so that the drawer **205** can be partially opened providing access to the requested tape cartridge **515**. As previously described, the lock spring **100** preferably inhibits complete removal of the drawer **205**. For complete removal of the drawer **205**, the lock spring **100** is first released via insertion of  
25       the tool into an opening **520**.

      Figure 6 is another drawing of the example application of figure 5 of the device **100** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. Figure 6 is a drawing of the detail indicated in figure 5. Figure 6 shows the lock spring **100** in first  
30       and second positions **215, 220**. In the first position **215**, the impact of the stop **212** against

the second section 110 of the lock spring 100 prevents complete removal of the drawer 205 from the tape changer. To enable complete removal of the drawer 205, the tool 230 is inserted into the opening 520 and then forces the lock spring 100 to rotate as indicated by rotation arrow 605 from the first position 215 to the second position 220. Rotation is  
5 stopped by means of a rotation stop 610. In the second position 220, the second section 110 is moved such that it no longer impedes the movement of the drawer 205 with respect to the chassis 210 and can be completely removed from the autochanger chassis 210.

A primary advantage of the embodiment as described in the present patent  
10 document over prior lock springs and interlocking mechanisms is its simplicity and the fact that it can be fabricated inexpensively.